DEPARTMENT OF AGRICULTURE WEATHER PROGRAMS

The Nation's food and fiber products are a critical resource impacting our domestic and international economic situation and are essential for ensuring our national security and shaping foreign policy. Weather is the most important factor influencing the Nation's variability in crop yields and related production. The United States Department of Agriculture (USDA) monitors global weather and agricultural developments through the Joint Agricultural Weather Facility (JAWF). The JAWF provides critical information to decision-makers formulating crop production forecasts, programs that provide natural disaster assistance to U.S. farmers and ranchers, emergency relief programs, and trade policy. USDA operates specialized weather observing networks such as SNOTEL, SCAN, and RAWS that provide vital data and information used to forecast seasonal water supplies in the West, to support national conservation programs, and to monitor the health of the Nation's forests. USDA conducts supporting research that focuses on understanding the interactions of weather and climate with plants, animals, forests, and forest ecological systems.

Numerous agencies within the U.S. Department of Agriculture (USDA) require a wide range of high quality weather and climatological data to successfully carry out their missions. Some of the diverse applications that require accurate, timely, and comprehensive data include crop monitoring and weather impact assessment, agricultural yield and productivity modeling, natural resource conservation planning, forest fire potential monitoring, irrigation scheduling, water supply information, reinsurance and compliance programs, crop disaster assistance and emergency relief programs, integrated past management, crop yield modeling, and agricultural research studies. The following is a brief description of agency weather activities.

OFFICE OF THE CHIEF ECONOMIST /WORLD AGRICULTURAL OUTLOOK BOARD

The World Agricultural Outlook Board (WAOB) is located within the Office of the Chief Economist (OCE). The WAOB's primary objectives are consistency, objectivity, and reliability of outlook and situation related material, including weather information developed within the USDA. The WAOB coordinates all weather and climate information and monitoring activities within USDA. The WAOB also manages the Joint Agricultural Weather Facility (JAWF), which serves as the focal point in the USDA for weather and climate information and impact assessment.

THE JAWF was created in 1978 as an operational unit, and is jointly managed by the USDA/OCE/WAOB and the U.S. Department of Commerce (DOC)/National Oceanic and Atmospheric Administration (NOAA)/ National Weather Service (NWS)/National Centers for Environmental Prediction (NCEP)/Climate Prediction Center (CPC). The primary mission of the JAWF is to routinely collect global weather data and agricultural information to assess the impact of growing season weather conditions on crops and livestock production prospects. JAWF meteorologists work as a team, monitoring global weather conditions and crop developments on a daily basis, and preparing real-time agricultural assessments (Figure 3-USDA-1). These assessments keep USDA commodity analysts, the OCE, and the Secretary of Agriculture and top staff informed of worldwide weather related develop-

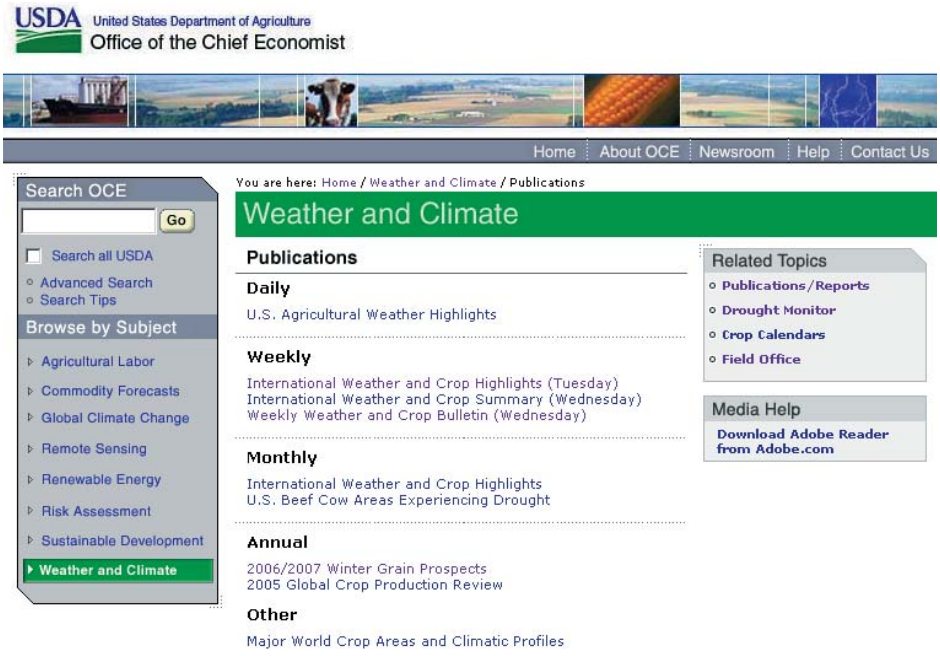

Figure 3-USDA-1. Joint Agricultural Weather Facility Web Site.

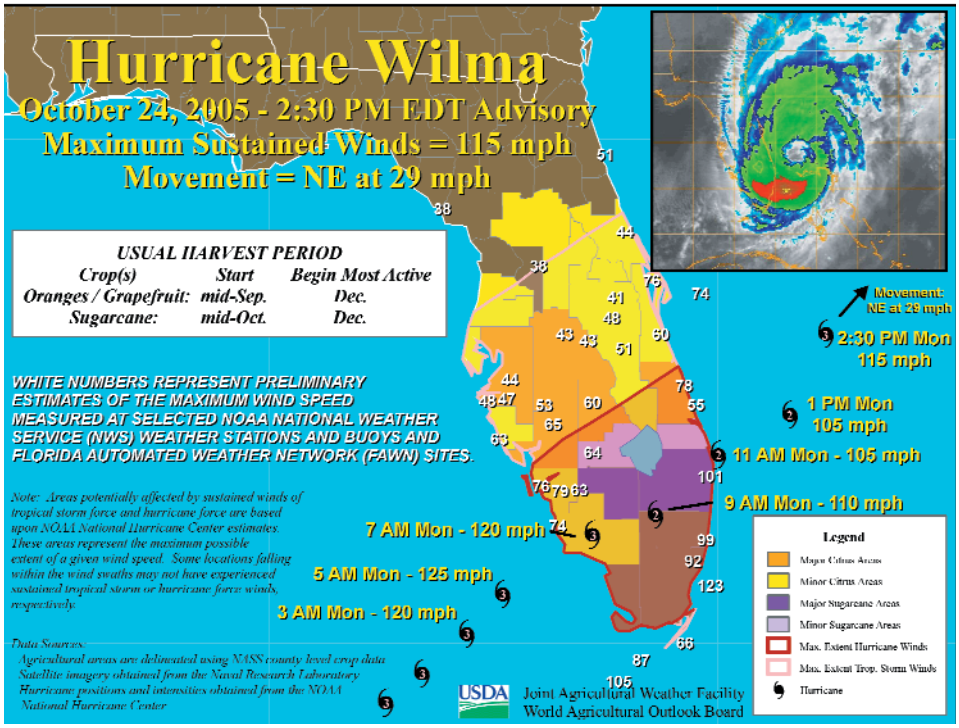

Figure 3-USDA-2. Special agricultural assessment example - Hurricane Wilma.

ments and their effects on crops and livestock. In addition to providing routine assessments, OCE/WAOB agricultural meteorologists at JAWF are frequently requested to prepare special assessments when adverse or anomalous weather conditions (i.e., droughts, heat waves, freezes, floods, and hurricanes) are observed in major crop producing regions. An example of an assessment made during Hurricane Wilma is shown in Figure 3-USDA-2. This special assessment was prepared using sophisticated GIS tools, overlaying the track and sustained wind speeds of the hurricane over Florida citrus and sugarcane producing areas. When integrated with economic analyses and information, these routine and special crop-weather assessments provide critical information to decision-makers formulating crop production forecasts, trade policy, and disaster relief. They also help identify potential agricultural markets for U.S. products around the world. Inputs from OCE/WAOB/JAWF are integrated into USDA's monthly foreign crop production estimates. Weekly briefings on global weather and crop developments are provided to USDA top staff. The Senate and House Agricultural Committees periodically request agricultural weather briefings that focus on the severity and impact of drought, heat waves, and excessive wetness in major crop areas across the Nation.

The JAWF serves as the USDA focal point for weather data received from the Global Observing System, a worldwide network of over 7,000 meteorological reporting stations managed by the World Meteorological Organization (WMO). These data are used at JAWF and other USDA agencies for a number of agricultural applications. The agricultural meteorologists of OCE/WAOB/JAWF merge these weather data with climatological analyses and global agronomic data, to determine the weather's impact on crop development and yield potential. A major source of domestic weather and climate data that are used in crop and weather analyses by JAWF comes from the NWS's Cooperative Observer (COOP) Network.

JAWF's flagship publication is the *Weekly Weather and Crop Bulletin (WWCB)*. The WWCB is jointly produced by USDA/OCE/WAOB, USDA/National Agricultural Statistics Service (NASS), and the DOC/NOAA/NWS/NCEP/CPC. First published in 1872 as the *Weekly Weather Chronicle*, the publication has evolved over the past 134 years into one that provides a vital source of information on weather, climate, and agricultural developments worldwide. The publication is a shining example of how two major departments (USDA and DOC) within the Federal government can mutually cooperate, combining meteorology and agriculture expertise to provide a service that benefits the economic well being of the nation. The *WWCB* (Figure 3-USDA-3) highlights weekly meteorological and agricultural developments on a national and international scale, providing written summaries of weather and climate conditions affecting agriculture, as well as detailed maps and tables of agrometeorological information that is appropriate for the season.

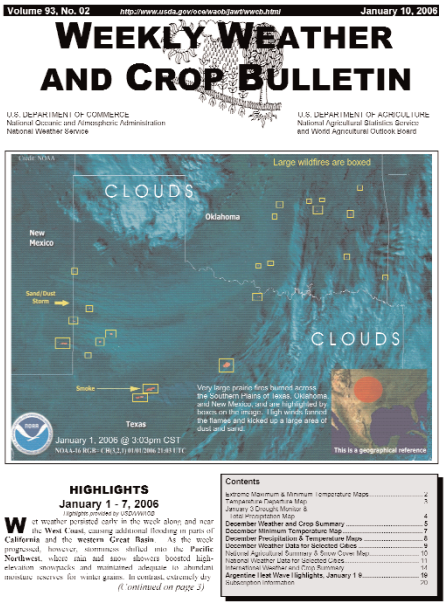

Figure 3-USDA-3. *Weekly Weather and Crop Bulletin* is a joint effort of between the Departments of Agriculture and Commerce.

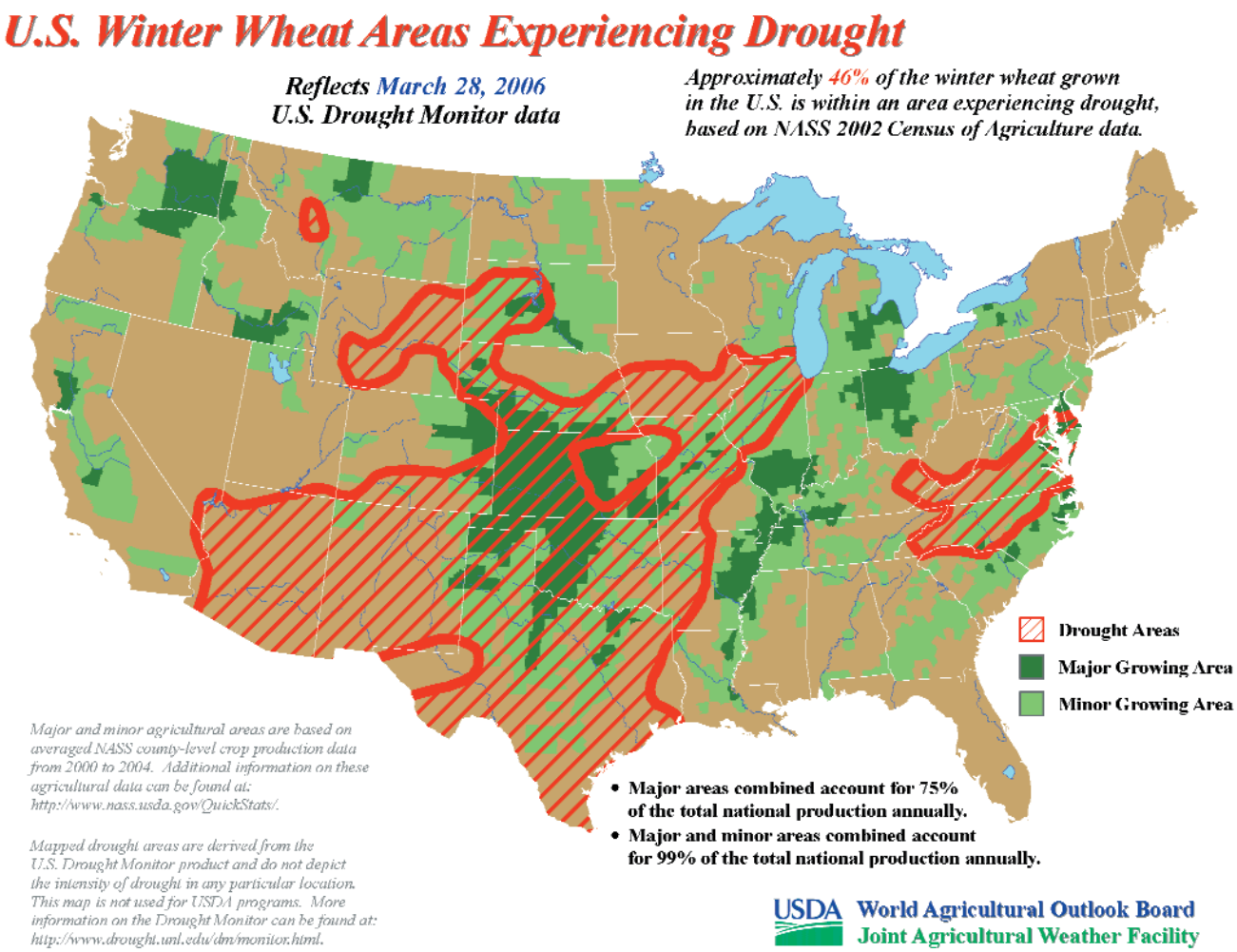

Figure 3-USDA-4. A monthly update of United States winter wheat areas experiencing moderate or more intense drought.

The *WWCB* also provides timely weather and crop information between the monthly *Crop Production* and *World Agricultural Supply and Demand Estimates* reports, issued by USDA/NASS and USDA/OCE/WAOB, respectively. The *WWCB* is available in electronic form from the OCE web site at: *http://www.usda.gov/oce/weather/index.htm*.

Knowledge of historical climate data and agricultural production patterns in agricultural regions around the world is critical in JAWF's assessments of weather's impact on crop yields. In September 1994, OCE/WAOB/JAWF published the *Major World Crop Areas and Climatic Profiles* (Agricultural Handbook No.664). This reference handbook provides the framework for assessing the weather's impact on world crop production by providing information on climate and crop data for key producing regions and countries. Coverage includes major agricultural regions and crops, including coarse grains, winter and spring wheat, rice, major oilseeds, sugar, and cotton. World maps show the normal developmental stage of regional crops by month. An electronic version of the handbook was developed to provide periodic updates to the printed version as additional data become available. The electronic version is available from the OCE web site at: *http://www.usda.gov/oce/weather/pubs/Other/MWCACP/index.htm*.

Drought is one of the most costly natural disasters affecting the U.S. In the summer of 1999, a monitoring tool known as the *Drought Monitor* was developed to help assess drought conditions in the U.S. The *Drought Monitor* is a collaborative effort between Federal and academic partners, including the University of Nebraska-Lincoln National Drought Mitigation Center, OCE/WAOB/JAWF, NOAA/NWS/CPC, and NOAA/NESDIS/National Climatic Data Center. Approximately ten lead authors rotate the responsibility of preparing the *Drought Monitor*. Produced on a weekly basis, the *Drought Monitor* is a synthesis of multiple indices, outlooks, and impacts depicted on a map and in narrative form. The official web site for the *Drought Monitor* can be found at: *http://www.drought.unl.edu/dm/monitor.html*. The *Drought Monitor* is released each Thursday at 8:30 A.M. Eastern Local Time. Because the *Drought Monitor* is prepared in a GIS system, it can be overlaid on agricul-

tural data, to create agricultural weather products that quantify the spatial extent of drought affecting various agricultural commodities (Figure 3-USDA-4). These agricultural weather products, along with the *Drought Monitor*, serve as the main source of information for briefing materials on U.S. drought developments for the Department's Drought Task Force.

The *North American Drought Monitor (NADM)* is a cooperative effort between drought experts in Canada, Mexico, and the U.S. to monitor drought across the continent. The NADM was initiated at a workshop in April 2002, and is part of a larger effort to improve the monitoring of climate extremes on the continent. Issued monthly since March 2003, the NADM is based on the end-of-month *U.S. Drought Monitor* analysis and input from scientists in Canada and Mexico. Major participants in the NADM program include the entities involved with the production of the *U.S. Drought Monitor*, as well as Agriculture and Agrifood Canada, the Meteorological Service of Canada, and the National Meteorological Service of Mexico. The NADM web site is: *http://lwf.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/nadm-map.html.*

USDA's Chief Meteorologist is currently serving as the president of World Meteorological Organization's (WMO's) Commission for Agricultural Meteorology. In this position, the USDA's Chief Meteorologist leads an effort to enhance the flow of more accurate and timely global agricultural weather information through an ongoing project utilizing Internet technology. The World AgroMeteorological Information Service (WAMIS) is a dedicated web server that provides agrometeorological bulletins and advisories issued by WMO Members to the global agricultural community as well as training modules to aid Members in improving their agrometeorological products. Currently, 25 member services contribute advisories and bulletins to the WAMIS web server. The WAMIS web site is: *http://www.wamis.org*.

The OCE/WAOB/JAWF opened a field office in Stoneville, Mississippi in October 1998. The OCE office in Stoneville, Mississippi is co-located with the Mississippi State Delta Research and Extension Center (DREC) and USDA's Agricultural Research Service (ARS) Mid-South Area Jamie Whitten Delta States Research Center. A primary goal of the field office is to access and link existing agricultural weather data collection networks to assist with the nationwide flow of agricultural weather data and information. This goal is being achieved through ongoing cooperative efforts with other state, public, and government institutions engaged in agricultural weather activities and climate services, including the states of Missouri, Iowa, Alabama, Mississippi, Oklahoma, Illinois, Louisiana, Indiana, NOAA's Regional Climate Centers, USDA's Natural Resources Conservation Service (NRCS), and the U.S. Department of Interior/Bureau of Reclamation/Pacific Northwest Region AgriMet Program. Interactions with these other agencies have helped to ensure the availability of soil temperature data, previously unavailable on a national scale. These soil temperature data are published during the spring and early summer in the *WWCB*. Such data are critical in providing guidance to farmers on when soil temperatures have reached high enough levels to begin planting field crops.

FOREST SERVICE

RESEARCH

Pollutants and emissions from prescribed and wildland fires are decreasing current and future air quality. Forest Service meteorologists are working with biological and social scientists to look at how land use changes (such as transportation patterns), and forest species distributions impact air quality and forest health. Predictions of prescribed and wildland fire and smoke emissions and transport are being used to assess the added impact of fires on air quality and as a planning tool for scheduling prescribed burns to reduce the buildup of hazardous fuels. Research at the Missoula Fire Laboratory, in cooperation with other partners, forms the foundation for many fire weather products as well as smoke management guidelines. Predicting emissions factors from fires and modeling smoke dispersion provides estimates of smoke impacts on human health and relationships between on-site meteorology and smoke dispersion including consequences of smoke to visibility in Clean Air Act Class I Areas.

Air pollution effects remain a serious threat to forest health in some parts of the U.S. Research is focusing on sampling methods and quantifying air quality (nitrogen and ozone) and air quality related values, particularly in remote areas, and on measuring and quantifying impacts of nitrogen deposition on alpine and subalpine terrestrial and aquatic ecosystems. Forest Service's research is also investigating nitrogen deposition in selected forest ecosystems across the U.S., with particular attention to nitrogen deposition effects on nutrient cycling, soil and water chemistry, soil microbiology, plant species composition and abundance, and ecosystem function.

NATIONAL FOREST SYSTEM

The National Forest System weather program works with the USDA Drought Commission. It provides liaison with the Satellite Telemetry Working Group (STWG) on satellite services and with the National Weather Service, DOI, and NWCG on the delivery of fire weather forecasting,

critical for safety and effectiveness of fire fighting and for flash flood warnings. The Forest Service watershed management program provides assistance to the NRCS by conducting snow surveys in 11 western states and Alaska on National Forest System lands to maximize safety and efficiency. Cooperative efforts with NRCS and USGS in the Eastern U.S. include monitoring air and weather stations on National Forest System lands in wilderness areas as well as near large urban centers. This information provides the basis for modification of forest structure through the deposition and melt of snow, flood forecasting, fire season risk, and water management decisions affecting aquatic species, agriculture, hydro-electric, transport & international treaties. Land management and timber harvest impact water yields and storage, can enhance existing water supplies, and can be consistent with other resource uses and values. Snow augmentation or other modification activities carried out by cooperators are consistent with applicable laws, regulations and management guidelines for National Forest System lands.

FIRE AND AVIATION MANAGEMENT

This program uses meteorological data, analysis and prediction tools and expert interpretation skills for decision making regarding wildland fire management including wildfire, wildland fire use and prescribed fire activities. The Forest Service State and Private Forestry, Fire and Aviation Management (F&AM) program operates a network of over 1000 remote automated weather stations (RAWS) in a national network of over 2500 stations. The network provides real-time meteorological information which is key in processing the National Fire Danger Rating System (NFDRS) via the Weather Information Management System (WIMS) used by fire agencies across the country.

The program provides liaison with the Satellite Telemetry Interagency Working Group (STIWG) and its associated Technical Working Group; the National Weather Service (NWS); DOI agencies including the Bureau of Land Management (BLM), Fish and Wildlife Service (FWS), Bureau of Indian Affairs (BIA), and National Park Service (NPS); state fire protection agencies; and the National Wildfire Coordinating Group (NWCG) on the delivery of fire weather data and forecasting, critical for safety and effectiveness in wildland fire management. The RAWS Program assures that the USFS network is in compliance with the National Fire Danger Rating Weather Station Standards; and serves as key contact for any changes to that document on behalf of the Fire Environment Working Team (FENWT). The FS F&AM participates on the NWCG FENWT and other fire weather-related groups to address fire weather standards, translation of fire weather information into models and fire behavior support tools. The FS F&AM program is participating on the OFCM Joint Action Group for the National Wildland Fire Weather Needs Assessment which should be complete in 2007. The RAWS Program provides extensive support to local fire management and national fire management personnel through the hosting and maintenance of the Interagency RAWS web site. The web site address is http://www.fs.fed.us/raws.

The data from this network of stations form the basis for the assessment of fire danger, the pre-positioning of fire fighting resources and the conducting of prescribed fire operations including management of smoke. The costs include maintenance support contracts, maintenance training sessions, contracts for the delivery of this information to agency personnel, fire weather forecasters, and state forestry agencies that use the data in real-time for critical decisions.

The agency fire weather program works with the National Predictive Service Group (NPSG) at the National Interagency Fire Center (NIFC), Boise, ID, in providing technical support and oversight to 10 Geographic Area Coordination Centers and works closely with the Forest Service Research and Development staff in the oversight of the 5 regional Fire Consortia for Advanced Modeling of Meteorology and Smoke. This effort, in cooperation with NOAA and EPA, will provide valuable fire weather predictions, smoke forecasting and air quality information to fire managers and air quality programs nationally.

The F&AM program participates in the Automated Lightning Detection Contract to support quick response to new wildland fire ignitions. The data is delivered in real-time via the BLM's Wildland Fire Management Information System (WFMI). WFMI is accessible via the internet with correct logon and password credentials. State and private forestry agencies are also allowed access to the data through FS sponsorship and funding. The contract with Vaisala is held by the National Weather Service on behalf of several Federal government agencies.

The RAWS program is participating in an interagency Competitive Sourcing Study of the maintenance support required to keep the RAWS network operational and accurate. The study is being led by the BLM. The results will affect all Federal wildland fire agencies and many state forestry agencies and private users. At the conclusion of the study, the newly formed Most Efficient Organization (MEO) will include employees and workload from the USFS, BLM, BIA, NPS, and FWS.

NATURAL RESOURCES CONSERVATION SERVICE)(NRCS)

SNOW SURVEY AND WATER SUPPLY FORECASTING - MONITORING

Snowmelt provides approximately 80 percent of the streamflow in the western U.S.. The NRCS, in partnership with other Federal and state agencies, operates the Snow Survey and Water Supply Forecasting Program (SS&WSF) in 11 western states and Alaska. To accurately forecast seasonal water supplies, the program collects critical snow and climate data from high elevation snow packs in the mountainous western U.S. The data collection system includes 922 manual snow courses and over 703 automated SNOTEL (SNOw pack TELemetry) monitoring stations throughout the western U.S. These data, along with information from 740 stream gauges, 399 major reservoirs, and 3,200 climatological observing stations are merged into a hydroclimatic database that is used to produce real-time watershed analyses and water supply forecasts. Monitoring is done in partnership with Federal, state, and local agencies, power companies, irrigation districts, and the Provincial Government of British Columbia. This information is the basis for water management decisions under international treaties with Canada and Mexico.

The SNOTEL automated data collection system plays an important role by providing near real-time remote hydrometeorological data required to evaluate snowpacks, potential in-stream water supplies and drought risk. The SNOTEL network can provide hourly precipitation, temperature, and snowpack depletion information that significantly improves flood stage forecasts and the monitoring of other life threatening snow-related events. SNOTEL information enables emergency management agencies to effectively mitigate drought and flood damages. An added benefit during the late spring and summer is the availability of hourly climate data, which is used to monitor and assess forest and wildfire potential.

Additionally, the SS&WSF Program supports research to improve monitoring technology, data reliability, data quality, water supply forecasting, and water resource modeling.

WATER SUPPLY FORECASTS

Monthly water supply forecasts are produced each year, January through June, in partnership with the NWS. The purposes of water supply forecasts are to: (1) help irrigators make the most effective use of limited water supplies for agricultural production needs; (2) assist the Federal government in administering international water treaties with Canada and Mexico; (3) assist state governments in managing intrastate streams and interstate water compacts; (4) assist municipalities in planning the early management of anticipated water supplies and drought mitigation; (5) operate reservoirs to satisfy multiple use demands including hydropower generation; (6) mitigate flood damages in levied areas and downstream from reservoirs; and (7) support fish and wildlife management activities associated with species protection legislation.

During a typical forecast season, the NRCS SS&WSF Program issues approximately 11,400 seasonal water supply forecasts for 711 locations in 12 Western states. The water supply forecasts are coordinated and peer reviewed by a number of Federal agencies and cooperators to ensure the highest quality and accuracy. Major cooperators include the Bureau of Reclamation, Corps of Engineers, Bonneville Power Authority, state and local agencies, power utilities, irrigation districts, Tribal Nations, the Provincial Government of British Columbia, the Yukon Territory and Mexico. The primary users of this information include agricultural, municipal, industrial, hydropower, and recreation organizations. Recent Federal legislation related to endangered species protection has placed increased emphasis on timely and accurate forecasts.

The NWCC web site provides snow data, analyses, and forecasts efficiently to approximately 80,000 users. The web site experiences over 2.4 million accesses per month during the snow season.

DROUGHT ASSESSMENT

The SS&WSF Program provides a variety of climate and water supply products that are used to assess western U.S. drought. These include SNOTEL snow pack and precipitation analysis in the mountains, water supply forecasts, and state Surface Water Supply Indexes (SWSI). These products are critical to the weekly production of the interagency *Drought Monitor* web-based report. A cooperative, nationwide network of 108 Soil Climate Analysis Network (SCAN) sites in 39 states monitors soil temperatures and soil moisture to support national drought monitoring, production agriculture, and climate change research.

CLIMATE INFORMATION

NRCS provides climate data and products that directly support agriculture and conservation activities nationwide. Digital maps of monthly and annual precipitation and temperature for the U.S. are available from the NWCC web site (Figure 3-USDA-5). To meet the needs for real-time climate in formation and analysis, the SS&WSF program and the NOAA climate program are sponsoring the Applied Climate Information System (ACIS). ACIS is an internet-based climate data delivery system that provides the NRCS field offices, USDA, and partners with internet access to thousands of climate data sets collected by scores of Federal, state, and county networks. To support agricultural modeling efforts, the NWCC is also providing serially complete (i.e., no missing data values) temperature and precipitation data for approximately 11,000 climate stations nationwide. NRCS long range planning is supported by the Generation of weather Elements for Multiple (GEM)

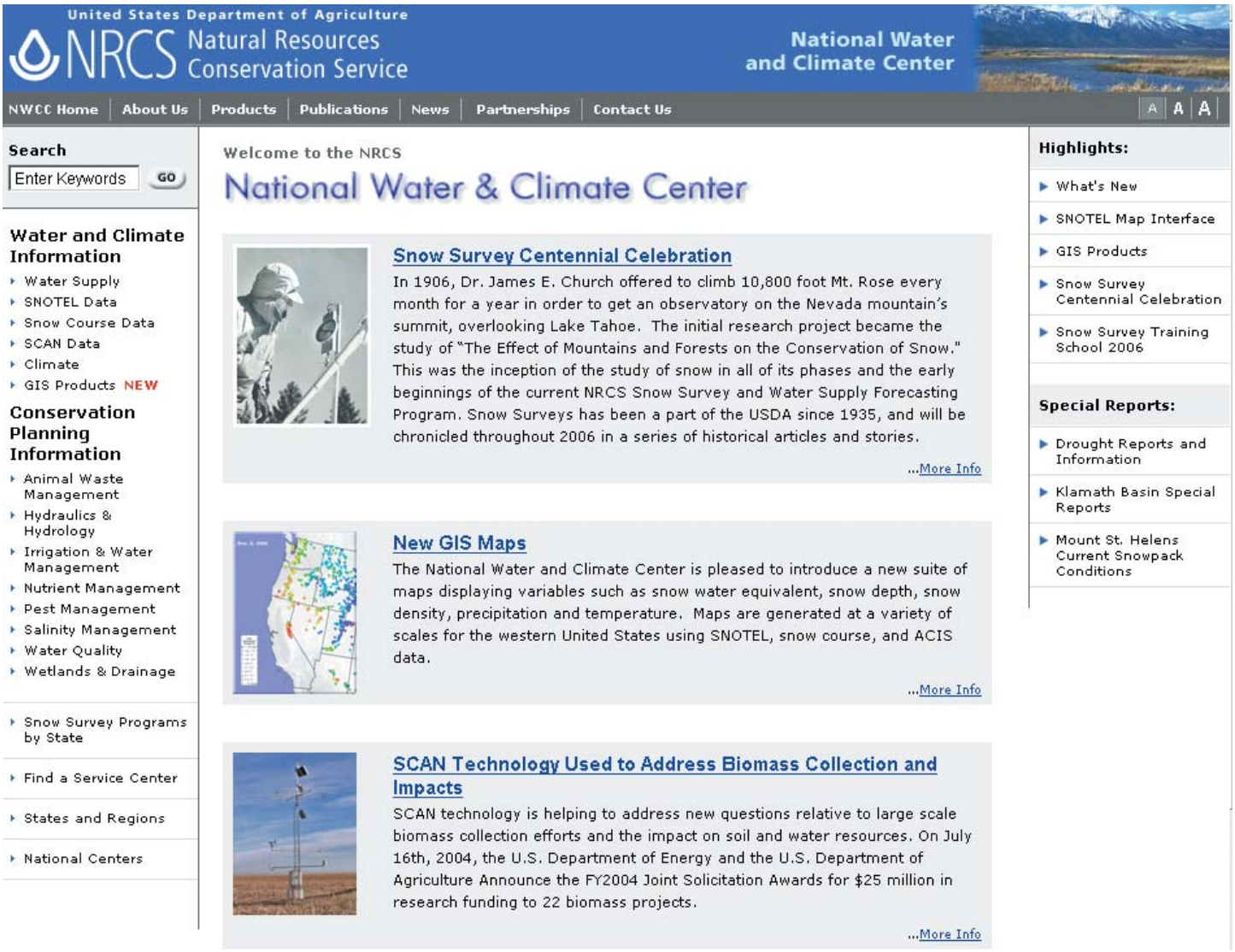

Figure 3-USDA-5. Natural Resources Conservation Service Web Site, where digital maps of monthly and annual precipitation and temperature are available.

applications model, which has been used to generate future climate data sets for more than 250 locations nationwide. GEM is being integrated with several NRCS environmental models. Monthly precipitation averages and growing season length information required for wetlands analysis are also available from the NWCC web site at over 6,000 locations in the United States, plus Guam and Puerto Rico. Finally, wind roses for 237 NWS stations in the United States, plus offices in Guam and Puerto Rico are now available from the NWCC web site. A wind rose gives a very succinct but information-laden view of how wind speed and direction are typically distributed at a particular location. Wind roses are useful planning tools for agricultural and natural resource planning.

AGRICULTURAL RESEARCH SERVICE

Research in this area focuses on how annual variation in weather impacts crop and animal production, soil erosion, irrigation scheduling, water availability, fate and transport of pollutants, and the environmental and economic sustainability of agricultural enterprises. Scientists are developing algorithms and decision support systems for the development of a stochastic storm-generator model and methodology to use contemporary weather radar systems to determine rainfall amounts and the spatial distribution and variability in precipitation associated with individual storms. Scientists are working on incorporating weather information and climate forecasts to improve irrigation scheduling and water use efficiency across the western U.S. Research in conjunction with NRCS and NASA is being conducted to map snow packs and predict water yield in the western U.S. The ARS watershed network is partnering with the NRCS in measuring and reporting soil temperature and moisture (Soil Climate Analysis Network (SCAN)) in addition to standard weather variables to help in

understanding and forecasting the impact of drought on crop and forage production across the nation. Additional research is being conducted to integrate seasonal forecasts, other information on extended climate departures from normal and extreme events, corresponding agricultural responses, and associated uncertainties into planning and management decision aids readily useable by producers. The research is conducted in collaboration with the NOAA forecast developers.

COOPERATIVE STATE RESEARCH, EDUCATION AND EXTENSION SERVICE

Funding from the Cooperative State Research, Education and Extension Service (CSREES) supports research projects that collect and process long-term weather and climatic data and provide immediate and future use as a base of information for the projection and prediction of climatic trends related to environmental impacts of human activities, soils, crops and domestic animals on agroecosystems, forest, and rangelands. Broader areas of study involve climatic dynamics, carbon and water cycling, and their role in global change. The impact of changes in UV and ozone level studies also fit into this broad global category.

Historical climatic changes are related to trends visible from present data gathering studies, enabling prediction of future crop production and irrigation needs. CSREES funding supports studies on the impact of climate and weather on food and fiber production. These studies relate to forest plant growth, rangeland productivity, cropping system selection and livestock production practices.

Man's impact on climate systems is also well represented in studies of both micro- and macro-climatic change. These involve studies dealing with the climatic impact of changes in air quality, water quality and point/non-point pollution related to agricultural practices and forest and urban development. Studies on climatic impact on nutrient cycling and carbon sequestration are supported with CSREES funds. Research is also being supported that quantifies the impact of climate change on the incidence and severity of plant and animal diseases and pests, invasive species, and biodiversity.

The National Research Initiative (NRI) has funded a wide variety of weather and climate research. Topics have varied from a number of fundamental plant drought tolerance studies to using meteorological data to forecast market performance. Much of the support in this area is also focused on climate change. The NRI has also funded research on how land changes have influenced climate and vice versa.